How policy marginalizes diversity: politics of knowledge in India's biodiesel promotion

Article (Published Version)

Science as Culture

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/csac20

How Policy Marginalizes Diversity: Politics of Knowledge in India's Biodiesel Promotion

Evelien de Hoop & Saurabh Arora

To cite this article: Evelien de Hoop & Saurabh Arora (2020): How Policy Marginalizes Diversity: Politics of Knowledge in India's Biodiesel Promotion, Science as Culture, DOI: 10.1080/09505431.2020.1820473

To link to this article: https://doi.org/10.1080/09505431.2020.1820473

Published online: 25 Sep 2020.

SCIENCE AS CULTURE
https://doi.org/10.1080/09505431.2020.1820473

Routledge
Taylor & Francis Group

How Policy Marginalizes Diversity: Politics of Knowledge in India's Biodiesel Promotion

Evelien de Hoop [a] and Saurabh Arora[b]

[a]Copernicus Institute of Sustainable Development/Athena Institute, Utrecht University/VU Amsterdam, Amsterdam, Netherlands; [b]Science Policy Research Unit, University of Sussex, Brighton, UK

ABSTRACT

India's 2009 policy on biodiesel remains controversial to date. It excludes voices of marginalized people such as landless workers and knowledges associated with diverse feedstock cultivation practices. It considers the 'upscaling' of biodiesel production to be straightforward, based on easy transferability between diverse socio-material contexts. The policy's marginalization of the immense diversity of India's lands, peoples, perspectives, and practices is based on a neglect of socio-material relations and their multiplicity. A relational analysis highlights the need for alternate inclusive policy processes. Such processes include as evidence the diverse knowledges of interested people and relevant things. They recognize that each entity is known differently depending on *how* its socio-material relations are approached. Inclusive policy processes also highlight the adjustments that are required to translate a policy out of one socio-material setting and into another. Finally, inclusive policy processes help build realities relying not only on the knowledges from policy experts and firms, but also on the marginalized knowledges of grassroots actors such as smallholders and environmental activists.

KEYWORDS

policy assemblages; knowledge politics; participation; inclusion; biofuels; sustainability

Introduction

Since the release of India's National Mission on Bio-Diesel in 2003 (Planning Commission, 2003), biodiesel in India has been embroiled in an intense, multi-sided political controversy. Central to the controversy in India and in many other countries are issues such as land classifications, smallholders' incomes, and the role of high-yielding seeds (Baka, 2014; de Hoop *et al.*, 2016). For instance, the argument that millions of hectares of the so-called wasteland are available for growing biodiesel feedstock in India (e.g. Gopinathan

CONTACT Evelien de Hoop e.dehoop@uu.nl Copernicus Institute of Sustainable Development/Athena Institute, Utrecht University/VU Amsterdam, Princetonlaan 8a/de Boelelaan 1085, 3584 CB Utrecht/1081 HV, Amsterdam, Netherlands

and Sudhakaran, 2009) is criticized by activists and academics for exacerbating land grabs and displacing cattle grazing (Lahiri, 2009; Baka, 2014). Similarly, while some predict that biodiesel cash crops will be highly profitable (e.g. Misra and Murthy, 2011; Kumar *et al.*, 2012), others argue that the cultivation of crops such as *Jatropha curcas*, under the most favourable conditions, can be profitable only for large farmers. Smallholders growing Jatropha are considered vulnerable to crop failure and economic damage (see, for example, Ariza-Montobbio *et al.*, 2010; Rittenburg *et al.*, 2011; de Hoop, 2018).

In 2009, India released its National Policy on Biofuels. Political issues raised by the 2009 policy have not reached closure (Dalemans *et al.*, 2019). Societal and academic debates on the empirical evidence behind the policy are still ongoing (e.g. Shahare and Thayyil, 2020). In the face of these controversies, we ask: How are some knowledges made to count as 'evidence' in India's 2009 policy? How does the policy exclude diverse knowledges? How does this selectivity relate to the policy's overall aims? And how might policymaking be made more inclusive of marginalized knowledges? These questions are clearly relevant beyond biodiesel policymaking. Politics of diverse knowledges in policies are debated across many different areas, from climate change to agricultural development in India and internationally (see e.g. Arora, 2012; Mabeza, 2013; Strassheim and Kettunen, 2014; Brugnach *et al.*, 2017; Arora, 2019).

Past research engaging with India's biodiesel policy predominantly focuses on making substantive recommendations including: (a) the promotion of locally available flora (Agoramoorthy and Patel, 2011); (b) the cultivation of a wider diversity of (multi-purpose) crops (Rajagopal, 2008; Dewangan *et al.*, 2018); (c) amending land-use policy to facilitate cultivation on 'under – or un-utilized land reserves' (Altenburg *et al.*, 2009); (d) the recognition of existing uses of government-owned 'marginal' lands, such as cattle husbandry (Biswas *et al.*, 2010); and (e) improving conversion efficiency (e.g. Jungman *et al.*, 2016). These studies do not directly explore the political process of policymaking. Instead, they are concerned with making recommendations for a better biodiesel policy.

Studies on the process of biofuel policymaking more generally highlight 'political-economic forces' behind the policies and discuss how advocacy attempts by NGOs largely failed to change these policies. For example, Chaliganti and Müller (2016) point out how India's 2009 policy is underpinned by technocratic design principles. Pradhan and Ruysenaar (2014) show how NGOs unsuccessfully protested biodiesel policymaking on the grounds that the benefit to small farmers can only be very limited. Silencing smallholders' voices, the policy aimed to gain credibility from the support of high-profile actors keen on a strong pro-biodiesel policy. Such policies are ill-equipped to achieve the environmental and pro-poor developmental goals that they themselves define (Ariza-Montobbio *et al.*, 2010). Beyond India, Oliveira *et al.* (2017) demonstrate that biofuel policymaking is dominated by alliances between corporate and state

interests (e.g. energy security). To satisfy such interests, policies can cherry-pick evidence from a diverse body of uncertain knowledges (Parkhurst, 2017).

Responding to some of the concerns highlighted above, German and Goetz (2017) offer procedural recommendations for developing 'sustainable' biofuel policies. Calling for careful evaluation of biofuels' potential to achieve specific social and ecological aims and for an evidence-based participatory planning process, German *et al.* recommend that any 'scaling up' of biofuel production should be preceded by in-depth small-scale experimentation. While such a focus on policymaking processes rather than policy outcomes is useful, German *et al.*'s promotion of unproblematic evidence, 'evaluation' and 'experimentation' procedures fails to take seriously issues such as: (a) policy-driven production of evidence that instrumentally serves predefined policy aims (Holmes and Clark, 2008); (b) the political controversies surrounding biofuel knowledges (e.g. Rometsch, 2012; Rietig, 2016); and (c) the uncertainties and ambiguities that are inherent to all knowledge (Wynne, 1992; Stirling, 2015). As we will argue in this paper, participatory procedures that do not problematize what counts as evidence also obscure the complex webs of socio-material relations that afford the production of multiple knowledges of the 'same' entity (Mol, 2002; Latour, 2005).

We develop such a socio-material relational approach to the role of knowledge in policymaking. In this approach, the relations that matter for the production of knowledges and their articulation into policy, bring together not only the 'social' worlds of humans with their values and interests but also the 'material' worlds variously composed of tools, technologies, and the biophysical environment. The social and material worlds intermix and constitute each other (Latour, 2005). We develop this socio-material approach by focusing on the 2003–2009 policymaking process in India, examining the inclusion of some forms of knowledge as evidence and the accompanying exclusion of diverse knowledges. We conclude the paper by proposing three normative principles of inclusive policymaking processes. These are (a) articulating the diverse knowledges of interested people, associated with relevant things; (b) respecting each entity's multiplicity based on differences in the socio-material relations they are embedded in; and (c) recognizing the adjustments entailed in translating a policy from one socio-material setting to another.

A Relational Approach to Policymaking

Attempts to include diverse voices and interests in policymaking often promote 'public participation' (e.g. Nowlin, 2011; Ng'ombe *et al.*, 2012; Shahare and Thayyil, 2020). Inclusion through public participation in policymaking is argued to improve the effectiveness of problem-solving in society (Barry *et al.*, 2008; Lövbrand, 2011). Critiques of 'participation,' however, argue that it is often applied in instrumental and legalistic ways, without addressing power relations that prevent

the inclusion of diversity in the first place and that shape how public participation unfolds in practice (Stirling, 2008; Wesselink *et al.*, 2011).

Indeed, public participation can overlook the role of dominating political associations, economic interests, and state-based visions in policymaking (Jasanoff and Kim, 2009; Wetzstein and Le Heron, 2010). These associations, interests, and visions structure 'public reason' around particular techno-scientific evidence and developmentalist rationalities of national security and wealth creation, while obscuring uncertainties and marginalizing voices based on alternate plural knowledges (Stirling, 2008; Arora, 2019). Such marginalization and exclusion can be revealed by public controversies around sciences and technologies. Controversies bring into relief a wide range of contrasting voices associated with people and things, humans and non-humans, in society and nature (cf. Latour, 2005). These voices often express various 'lay' and 'expert' knowledge claims (Callon *et al.*, 2009).

All voices representing knowledge claims are not just raised by individual actors. Instead, they are produced relationally (Latour, 2005), by heterogeneous *assemblages* of interrelated humans and non-humans. In addition to bodies and skills, assemblages are composed of entities such as concepts, models, procedures, regulations, norms, interests, values, visions, material artefacts, and biophysical processes (Verran, 2009; Ureta, 2014).

A particular voice raised by a spokesperson to represent another human or non-human is contingent on the specific *composition* of their assemblage (Mol, 2002; Latour, 2010; Arora *et al.*, 2013). The 'same' (non)human can be represented in different ways. For example, a soil sample may be variously represented by different assemblages in pedology, smallholder agriculture, and anthropology (Latour, 1999). A pedology assemblage may include maps, field surveying techniques, fieldworkers collecting soil samples from a forest, plastic bags, the Munsell code,[1] and laboratory equipment. In contrast, a smallholder's assemblage might rely on the texture of soil felt between her fingers, its colour (without using a standardized code), dampness and odour, with the purpose of deciding which crops might be suitable to grow in the soil. The anthropologist's assemblage may be composed of entities such as a notebooks, pens, academic literature, (philosophical or sociological) concepts, a camera, and the skill of following her interlocutors as they perform everyday practices relating to soils.

Here, it is crucial to emphasize that we associate voices with humans *and* non-humans (Latour, 2005). Non-humans such as soil samples are enrolled into assemblages and their 'characteristics' are generally articulated through human spokespersons such as smallholders and soil scientists (Callon, 1986). As noted above, different spokespersons may know and speak for the same non-human differently, depending on the composition of their respective assemblages. Unfortunately, these plural assemblages entangling the same entity, and the resulting diversity of voices and knowledges, can be made invisible through centring attention on narrow evidence provided by 'expert' spokespersons.

On the basis of their acknowledged expertise, some spokespersons generally gain more influence in (participatory) policymaking processes. This unequal influence is buttressed by the policy assumption that voices associated with non-humans are based on *evidence* only if the spokespersons are modern scientists and engineers (as exemplified by German *et al.*'s 2017 procedural recommendations discussed above; also see Mitchell, 2002). In this process, some 'scientific' entities such as mathematical models and theoretical concepts composing the assemblages of modern scientists and engineers may be made public (Latour and Wiebel, 2005; Carolan, 2010). However, many other entities and relations constituting the same assemblages may be obscured or suppressed, including:

a) the occlusion of powerful interests and visions that shape knowledge production and lobbying through assemblages, in order to make some voices dominant as 'evidence' for policy (Jasanoff, 2004);
b) the suppression of situatedness and uncertainties inherent to all knowledge (Haraway, 1991; Stirling, 2015), which helps justify the view that policies based on techno-scientific knowledges are unproblematically transferrable out of a particular setting. This obscures the adjustments made to knowledges through learning and adaptation, as they are used in new settings;
c) the exclusion from policymaking of a wide range of voices based on knowledges produced in assemblages that are not controlled by modern scientists and engineers. The excluded voices are often articulated by spokespersons such as grassroots activists and small/marginal farmers.

The above forms of exclusion and suppression lead to a 'narrowing of vision' (cf. Scott, 1998; Palmer, 2014). They also help construct ostensibly neutral categories of 'the scientific' and 'the technical' by trying to separate modern sciences and technologies from politics (cf. Latour, 2004; Li, 2007).

Attempting to defy this separation and challenge modernist exclusions, we emphasize two aspects of the politics of assemblages that enable the raising of voices. First, the procedural, discursive, and material entities constituting an assemblage hang together in (asymmetric) relations of power (Callon, 2008; Verran, 2009). This means that some entities constituting an assemblage may be more powerful than others in shaping how a voice is raised. The more powerful entities may include economic interests of investors and scientific discourses considered accurate representations of reality. This means that all assemblages are *political*, including those producing modern techno-scientific facts and artefacts. Yet, as noted above, political assemblages controlled by modern 'expertise' can obscure how they are constituted by power. They can, therefore, be presumed as apolitical.

Second, a particular composition of an assemblage (at a specific time) is one of many existing and possible compositions (Mol, 2002; Lave, 2015). If this

multiplicity of assemblages is marginalized, some voices associated with an entity are silenced. Such silencing can create a situation that an entity is represented through just one voice, turning the entity into a *repetitive singularity*. As discussed above, the voice that is often favoured as authoritative evidence may be based on knowledge produced by an 'expert' assemblage that suppresses uncertainties and occludes how it is constituted by powerful political-economic forces (Latour, 1988; Stirling, 2008). By claiming an exclusive attachment to the categories 'science' and 'technology,' modern expert assemblages can marginalize other practitioners' knowledges by treating them as non-technical and non-scientific (Agrawal, 1995; Arora, 2019). Diverse technical, ecological, and medical knowledges may then be boxed into essentializing categories such as 'indigenous,' 'vernacular,' 'traditional,' 'local,' or even 'subaltern' (Kothari, 2002).

Building on the foregoing relational approach, we examine which voices (representing knowledges produced by different assemblages) were included and excluded in the making of India's controversial 2009 biodiesel policy. To facilitate this analysis, we approach policymaking as a process of articulating *propositions* (Latour, 2003, 2004; Prince, 2010; Freeman, 2012). A proposition carrying in it the verb 'to propose' is different from a statement. Unlike a statement, a proposition is always incomplete and in need of further adjustments. A proposition opens up debate and deliberation. It does not carry any definitive *a priori* authority. The process of developing propositions is uncertain: possible outcomes are not predictable; nor can any probabilities be attached to them.

Methods

If voices are raised through relations with others in political assemblages, mapping these voices requires a wide range of empirical materials from diverse sources. Therefore, we rely on document analysis, semi-ethnographic fieldwork, and semi-structured interviews. For document analysis, we obtained policy-relevant documents through Internet searches, from libraries, and from people working on biodiesel issues in India. The first author carried out multi-sited fieldwork from September–December 2012, September 2013–March 2014, and October–November 2015. She conducted 72 semi-structured interviews with biodiesel stakeholders, including national- and state-level policymakers (25) from the ministries involved in biodiesel, researchers (26) from universities and research institutes such as The Energy and Resources Institute (TERI), MS Swaminathan Research Foundation (MSSRF), and Tamil Nadu Agricultural University (TNAU), as well as business representatives (11) and activists (8). In addition, she visited agricultural research test fields, laboratories, and processing facilities to observe biodiesel production in action.

The second period of fieldwork (2013–2014) mainly consisted of everyday engagement with farmers and project officers involved in a specific biodiesel

project called 'Hassan biofuel park' in Karnataka. During this trip, and the final one (2015), a number of follow-up interviews were also conducted to clarify issues that emerged from early analysis. Throughout the multi-sited fieldwork, attempts were made to strike a careful balance between 'following the actors' as they travelled between different settings and ensuring substantial depth of understanding of each specific socio-material setting (Boccagni, 2014).

We begin our analysis below by disentangling India's 2009 biodiesel policy into five propositions. These propositions facilitate detailed analysis of the policy as a whole, based on the identification of the most salient issues in India's biodiesel policymaking as raised during our interviews and semi-ethnographic fieldwork. We analyse the emergence of each proposition based on events between 2003 and 2009, using the concepts of political assemblages and repetitive singularity. Finally, we offer concluding remarks by reflecting on our empirical findings.

Analysis: Articulating Biodiesel Propositions

The first two propositions we derive from India's 2009 biofuel policy focus on the policy's core aims: (1) the legitimation of biodiesel promotion; (2) set targets based on expected yields of biodiesel feedstock. The remaining three propositions focus on strategies to realize the above two aims: (3) by acquiring land to grow biodiesel; (4) by claiming to avoid competition with food production; and (5) by promoting specific feedstocks. Each of these five propositions from the 2009 policy has a counterpart in the Indian government's 2003 National Biodiesel Mission (Planning Commission, 2003).

Legitimating the Policy

The first policy proposition attempted to legitimate biodiesel production, claiming that it 'contributes to energy security, climate change mitigation, apart from creating new employment opportunities and leading to environmentally sustainable development' (Government of India, 2009, p. 4). This proposition's four constituting benefits (energy security, climate change mitigation, employment opportunities and environmentally sustainable development) were claimed to be generally realizable, in all socio-material settings, without directing attention to *how* biodiesel production is actually carried out. For example, if woodlands are cleared for biodiesel feedstock cultivation (Romijn, 2011), then climate change mitigation and wider environmental sustainability may both be compromised. Here, we examine how this proposition was assembled after 2003, within the wider political-economic context at the time in India and globally.

The 2003 Biodiesel Mission claimed that 'rural energy needs' will be met (Planning Commission, 2003). The 2009 policy did not mention rural energy,

instead emphasizing the reduction of national dependence on fossil fuel (oil) imports to increase energy security. Which political assemblages managed to push rural energy out of the picture between 2003 and 2009?

Encouraged by the 2003 Mission, some non-governmental organizations such as the Chennai-based AHIMSA had set up biodiesel production chains to meet rural energy needs, often operating without a profit motive. AHIMSA's project sold small quantities of oilseeds to a Swiss company and the Indian Railways, which made a marginal financial contribution towards sustaining local livelihoods. Jatropha curcas yields turned out to be too small to enable a workable rural energy system.

At the same time, transnational corporations started setting up commercial joint ventures with domestic firms, which contracted farmers in Tamil Nadu to grow Jatropha curcas as biodiesel feedstock. One such prominent joint venture, D1 Mohan Bio Oils Ltd, failed to keep the promise of buying the seeds supposed to be harvested three years after planting the saplings. The saplings also failed to deliver the yields promised to farmers by the company's extension workers (Ariza-Montobbio *et al.*, 2010). Another firm, Southern Online Bio Technologies Ltd, located their biodiesel production facilities in special economic zones to facilitate the import of feedstock from abroad, because domestic feedstock was hard to find, according to a manager of the company.

During our interviews, some policymakers, critical biodiesel researchers, and activists engaged in policy advocacy argued that the active presence of foreign corporations since 2003 and their imports of feedstock were crucial to the political assemblage that articulated 'contributing to national energy security' in the 2009 policy. This substituted 'meeting rural energy needs' articulated in the 2003 Mission. Clearly, 'meeting rural energy needs' offered fewer business opportunities (and profits) than working towards national energy security (as most energy is consumed in urban centres in India).

Critics further argued that the emphasis on national 'energy security' through domestic biodiesel production was a smokescreen that hid the import of feedstock and the deep involvement of multinational corporations (MNCs). There were in fact many instances of open promotion of MNC-involvement based on the 2009 policy. In the political assemblages shaping this policy proposition, the state, multinational corporations and imported feedstock appeared dominant. The less powerful voices of small famers and supporting NGOs were marginalized. Through this first proposition, the 2009 policy thus further facilitated corporate presence and control.

Regarding climate change, a number of academic studies suggested that biodiesel from Jatropha curcas did not necessarily result in the carbon savings claimed by biodiesel proponents (Kanninen *et al.*, 2007). Accounting for the replacement of existing biomass with Jatropha curcas, and for the use of fertilizers and irrigation required to cultivate the feedstock crop, the amount and

timing of CO_2 emissions associated with biodiesel production varied greatly. It all depended on the specific socio-material conditions in which feedstock crops were cultivated and processed into biodiesel – differences that were closely associated with the more or less industrialized smallholder and plantation-based production chains (see e.g. Reinhardt *et al.*, 2007; Romijn, 2011). The more industrialized conditions of cultivation used chemical inputs such as fertilizers and pesticides as well as carbon-intensive irrigation relying on groundwater extraction or dammed reservoirs and canals. Therefore, depending on the specific political assemblage of biodiesel production that CO_2 emissions were part of, they raised very different voices. Yet, these differences with regard to CO_2 emissions were not articulated in India's biodiesel policy and political questions about the socio-material conditions of biodiesel feedstock production were sidestepped.

The policy isolated CO_2 particles out of the different assemblages of interrelated socio-material entities that bring them into existence and produce their articulations. The policy proposition only highlighted the potential benefit of reduced emissions. This turned CO_2's voice into the *repetitive singularity* of 'reduced and avoided emissions through Jatropha cultivation and use'. As a result, CO_2's multiple (possible) articulations depending on the different political assemblages it was a part of were erased out of the policy proposition. The single voice of CO_2 dominating the policy proposition as evidence was raised by the political assemblage of biodiesel promotion. All alternate assemblages through which CO_2 emissions may be voiced in diverse ways were marginalized. If diverse voices of CO_2 were included in the proposition, raised through spokespersons such as citizen scientists and environmental activists, then India's biodiesel policy might have included the specific socio-material conditions required for achieving 'reduced and avoided' CO_2 emissions through the cultivation of biodiesel crops.

Reducing an entity to a repetitive singularity in a policy proposition facilitated the claim that the policy proposition was easily scalable, through straightforward *transfer* to other socio-material settings without any adjustments. For national policymakers, biodiesel production was of little use after all, in replacing fossil fuels, if it was not done at scale.

About employment generation, our respondents narrated how government biodiesel schemes implementing the 2003 Mission paid people in rural areas to plant Jatropha curcas and other feedstock bushes/trees on government-owned land. Yet the same schemes did not pay people for recurring work such as taking care of the plants and collecting seeds, under the assumption that selling the seeds provided adequate income to perform these tasks too. The 2003 Mission also envisaged employment opportunities on large plantations or in biodiesel production facilities such as transesterification plants. However, during our fieldwork, we learnt that very few companies and other organizations were running by 2009. Our interlocutors were unanimous in expressing that this is because Jatropha curcas's yields were significantly lower than expected.

The voices of rural people supposedly benefitting from biodiesel's employment generation were articulated in the policy only as 'people in need of employment.' These people were presumed poor according to economic definitions of 'below poverty line' households, and believed to be keen on any employment opportunities in biodiesel production without constraints. The policy made no reference to the workers' skills, tools, or any other entities composing their political assemblages required to participate in biodiesel production. Also excluded from the policy were the other assemblages that constitute rural people's everyday lives, in terms of their domestic, agricultural, or local administrative responsibilities.

Some of our interviewees, particularly social scientists and businesspeople, observed that rural people were reluctant to join or maintain their participation in biodiesel projects. For example, Mr Ramar of the MGR Jatropha Biodiesel Project in Tamil Nadu noted that people were unwilling to work against the wages offered. He attributed the failure of their Jatropha project to this unwillingness. In contrast, the reason mentioned by policy officials interviewed for people's lack of participation in biodiesel production was often simply people's inability to grasp how much income they could have earned from biofuel projects. This reasoning turned rural people's voices into a repetitive singularity stressing their need for employment, while disarticulating them from the political assemblages of their everyday life (beyond a predefined poverty line and the presumed lack of employment). Excluded from the policy proposition were therefore voices associated with people's skills, their occupational concerns (for example as small farmers or landless workers), alternate employment opportunities, and other socio-material entities composing their domestic and farming assemblages.

Beyond the official policy propositions, political assemblages of rural people and their NGO partners produced alternate voices regarding the desirability of biodiesel employment. These alternate voices often expressed sharp divergence from the 2009 policy's articulation. For example, farmers in Hassan district of Karnataka argued that income from a day's work as a farm-labourer was considerably higher than that from a day spent collecting and processing biodiesel feedstock seeds (see Figure 1). Voices such as those of the farmers from Hassan, if included more clearly in the proposition, would have produced a very different policy.

Setting Targets

'An indicative target of 20% blending of biofuels, both for biodiesel and bioethanol by 2017 is proposed. Blending levels prescribed in regard to biodiesel are intended to be recommendatory in the near time' (Government of India, 2009, p. 4). This policy proposition on targets differed from the 2003 Mission: 'Targets need to be set up for bio-diesel production. The objective is to gradually

Figure 1. After collection, seeds were not ready for the market. Each seed also needed to be individually de-shelled, which was done by hitting the seed with a stone or stick. According to our respondents, this approximately doubled the amount of time required to get the seeds ready for market.

raise it to take it to 20% in the year 2011–12 beginning with 5% in 2006–07' (Planning Commission, 2003, p. x). The 2003 Mission further pointed out how calculations on the achievability of these targets were performed using: (a) yield estimates of Jatropha curcas, presumably from agronomists' test fields; (b) the expected oil content of Jatropha seeds extracted using a laboratory setup; and (c) the projected diesel demand in 2011–12 based on growth scenarios developed by economists. Relying on these the Mission calculates that a total of 11.19 million hectares of land were needed to achieve the blending target of 20% in 2011–12. No uncertainties were articulated. All differences between lands in terms of soil types and irrigation facilities were marginalized. The many interrelated entities constituting the political assemblages that produced oilseed yields (e.g. rainfall, irrigation, fertilizers, plant diseases, and pruning techniques) remained excluded.

The 2009 policy proposition on targets was more modest than the 2003 Mission proposition and was not based on calculations of Jatropha curcas' expected yields but rather on the promise of achieving targets by developing new high-yielding varieties of oilseeds. What was behind this shift with regard to both the targets themselves and their underpinning?

During our interviews, scientists, policymakers, and activists unanimously agreed that the Mission's calculations were subject to widespread criticism from around 2006 onwards. Critics highlight the Mission's authoring agency, the National Planning Commission, made a mistake by taking the yield of a stand-alone bush as representative of a bush in a densely planted field. On the latter fields, Jatropha recorded highly variable yields. For example, the political assemblage of scientists at the Tamil Nadu Agricultural University (TNAU) and plant scientists from the firm JOil in Coimbatore recorded wide differences in yields from carefully monitored cultivation practices and soil types (see Figure 2). Other research assemblages composed of experimental plots on which biodiesel varieties were intercropped with various kinds of lentils (e.g. in the test fields around the office of the Hassan biofuel park or the test fields of research organizations TERI and the Indian Institute of Oilseed Research), also produced lower yields than those expected by the 2003 Mission.

Crucially, a study on smallholders' actual experiences with Jatropha argued that most smallholders growing Jatropha achieved very low yields (Ariza-Montobbio *et al.*, 2010). In research sites, such as those of JOil, TNAU, and TERI, resource constraints on cultivation were very rarely comparable to the constraints faced by smallholder farmers (e.g. regarding the availability of water and other agricultural inputs). From interviews with organizations working directly with smallholders, it became clear that smallholders' political assemblages of Jatropha cultivation, each constituted by a specific web of entities including plot sizes, irrigation sources, soil types, fertilizers, and skills, produced a wide range of Jatropha yields (diverging from official 'expected yields'). On rainfed smallholdings, yields were made more variable by uncertain rainfall

Figure 2. Board hanging in the maintenance shed of one of JOils trial plots. Each part of the trial plot (letters A–R) received a different number of hours of irrigation on different weekdays. Photo: [first author].

patterns. Instead of directly articulating this variability of yields, and admitting that the yields were likely to be much lower than the 2003 Mission's expectation, the 2009 policy tied blending targets to the promise of 'high-yielding planting material' that was believed to solve the problem of low yields.

Beyond the assemblages that shaped the 2009 policy, a number of civil society and academic spokespersons associated diverse voices with 'high-yielding planting materials'. They problematized the policy's repetitive singularity of delivering higher yields. These diverse voices were based on experiences with different farming assemblages between 2003 and 2009. For example, two NGOs, Grain India and the Society for the Promotion of Wasteland Development (SPWD), as well as a scientist from the Directorate of Oilseed Research, highlighted the disjuncture between smallholder farms and research fields. They pointed out that on small farms, high-yielding planting materials' promised yields were difficult to achieve due to local resource constraints. Some NGOs, including SPWD, Anthra, and Grain India, also noted that cultivating high-yielding varieties often required the extensive use of external farm-inputs such as chemical pesticides and fertilizers that can cause serious environmental harm.

Such diverse voices highlighted uncertainties about feasible and desirable blending targets based on high-yielding varieties. Yet, they were largely silent in the 2009 policy. If included, the diverse voices can account for possible increases in socio-economic inequality due to the use of high-yielding varieties. Experience with these varieties was shown to firstly benefit the resource-rich farmers who can invest in the new seeds and other inputs such as fertilizers, tractors, and mechanical harvesters (Ariza-Montobbio *et al.*, 2010).

Land Where to Grow

The 2009 policy stipulated that biodiesel crops be grown: 'on Government/community wasteland, degraded or fallow land in forest and non-forest areas.' 'Contract farming on private wasteland could also be taken up […]. Plantations on agricultural lands will be discouraged. […] In all cases pertaining to land use for the plantations, consultations would be undertaken with the local communities through Gram Panchayats/Gram Sabhas' (Government of India, 2009, p. 7).

In contrast, the 2003 Biodiesel Mission made a blanket claim that a total of *13.4 million hectares* that was subdivided into categories ranging from agro-forestry to fallow lands, were available for biodiesel production. This claim was ostensibly based on calculations carried out by experts of the Planning Commission. Unlike the 2009 policy, public consultations were not emphasized in the 2003 Mission.

Between 2003 and 2009, spokespersons such as activists and farmers challenge the claim that 'wastelands' were uncultivated and unused. Such dissenting voices were, for example, central at a 2007 meeting of civil society actors in Hyderabad, attended amongst others by NGOs Anthra and SPWD. Here, it

was stressed that so-called wastelands were crucial for the food sovereignty of many rural families (Lavanya, 2007). By highlighting different uses of so-called wastelands across rural assemblages, such as for grazing and foraging, these voices helped transform the 2003 Mission's proposition about the availabilty of ample lands for Jatropha curcas cultivation. Unfortunately, however, the farmers' and activists' voices did not succeed in removing the term 'wasteland' from the 2009 policy.

In addition, activists asked if high yields of biodiesel crops can be realized on 'degraded-' or 'wastelands,' then the lands can surely also be used to grow food? The farmers we met during a visit to Anthra's office in Hyderabad described how government officials entered their village's grazing lands and planted Jatropha curcas and Pongamia pinnata (both biodiesel feedstocks), without prior permission and consent from any resident of the village. Farmers also admitted that they angrily uprooted the unwanted sapplings.

As Baka (2013) documented, plans to use 'wastelands' to realize biodiesel blending targets were part of a wider project by the Indian state, of converting 'wastelands' to ostensibly more 'productive' uses. This project can be traced back to British colonial times, when the privatization of lands classified as 'waste' was carried out in the name of social welfare (Gidwani, 1992; de Hoop and Arora, 2017). However, Baka argued that improving productivity or social welfare was simply a façade in the mechanics of 'wasteland governmentality,' which facilitated landgrabbing and rent appropriation by powerful actors in the state and private companies (Baka, 2013). Baka's claims were corroborated by a number of reports documenting extensive landgrabbing (e.g. Shiva and Shankar, 2008; Lahiri, 2009; Klaus *et al.*, 2011). Most reported land grabs took place before 2009, yet their voices were barely included in the 2009 policy. Instead the policy included, ostensibly as evidence, the voices of those holding the political and economic power to acquire 'wastelands' for cultivating 'high-yielding varieties.' These powerful voices were produced by assemblages controlled by associations of resource-rich farmers, agro-industrial firms that sell modernizing farm-inputs, and the agricultural research institutions that play a central role in developing the 'high-yielding varieties.'

Within villages, at the local level, some farmers aligned with the powerful voices of biofuel promotion through policy. Farmers favouring biofuels included those who relied on industrially produced feed for their animals; did not own animals; or owned enough private land to meet their own cattle-grazing needs. For example, in a village in Hassan district of Karnataka, a local leader took the initiative to invite the government to plant biodiesel crops on public land used by others in the village as grazing land. By becoming the sole spokesperson for political assemblages associated with 'uncultivated' land in his village, he marginalized the land's diverse and often contested uses.

Beyond these dominating political assemblages, diverse spokespersons such as small/marginal farmers and activists could have challenged the claimed

availability of land for biofuel cultivation (as we document in the following section). These voices had the potential to be raised through public 'consultation' with local communities. Such consultation was recommended by the 2009 policy. However, the policy failed to specify what 'consultation' actually meant and how binding the outcomes of consultations were going to be. Also, there was no recognition of the diversity of voices within 'local communities.' Different members belonging even to the same community, each embedded in their own assemblages that entangle landownership, soils of particular qualities, irrigation sources with caste and gender relations, often raised voices that were radically distinct from each other. Yet, no efforts were made to count this diversity of voices as evidence in the policy. Instead, the policy was turned into a repetitive singularity that simply proclaimed the need of public consultation, without actually specifying ways to include the outcomes of such consultations into policy. This also meant that the policy proposition was designed to be applied across diverse socio-material settings in India, without sensitivity to differences between and within these settings.

Food versus Fuel

'The Indian approach to biofuels, in particular, is somewhat different to the current international approaches which could lead to conflict with food security. It is based solely on non-food feedstocks to be raised on degraded or wastelands that are not suited to agriculture, thus avoiding a possible conflict of fuel vs. food security' (Government of India, 2009, pp. 3–4).

In the government's 2003 Mission, Jatropha curcas was the feedstock of choice. This choice was justified by agronomic knowledge claims of Jatropha's productivity without requiring substantial farm-inputs. The only reference to avoiding competition with other uses of lands, appeared in a foreword by the deputy prime minister L. K. Advani: 'The nation is facing a shortage of edible and non-edible oil. The existing high price of edible oil and the full use of tree borne oil seeds for various purposes suggest that organized biodiesel production for blending is possible only if plantation of selected species is taken up in compact areas' (Planning Commission, 2003). Such articulations of food vs. fuel competition were excluded from the 2009 policy.

In practice, many of our respondents observed that biodiesel feedstocks' competition with non-fuel uses was widespread between 2003 and 2009. For example, in Karnataka's Hassan district, Pongamia pinnata seeds were produced for the soap industry, and the oil was widely used for lighting lamps in religious ceremonies. A proportion of the seeds used for these purposes was diverted to feedstock for biodiesel, after the inception of Hassan Bio-Fuel Park in 2006. The Bio-Fuel Park also included Neem seed in its list of potential sources of feedstock to increase biodiesel production in the future. Yet, oil from neem (Azadirachta indica) is used 'traditionally' across India, for a range of medicinal and biopesticidal purposes. Such political assemblages producing diverse knowledges

and practices for non-biofuel uses of oilseeds such as pongamia (and possibly, of neem) were excluded from the 2009 policy.

Rather than taking such non-biofuel purposes seriously, the 2009 policy proposed to avoid food versus fuel conflict just by using non-edible crops and growing them on 'degraded' lands or 'wastelands.' The policy's aim was to circumvent the criticism that many biofuel policies received as part of global debates on biofuels' influence on food grain availability and prices (Baka, 2014). Voices associated with other entities constituting agricultural political assemblages, such as water, labour, farm-inputs, sunlight and root-space, were excluded from the policy.

In Hassan district, we observed how agricultural extension officers advise farmers to grow biodiesel crops, particularly Pongamia pinnata, on the boundaries of the farms that were used for growing food. This advice did not take into account the trees' possible interactions with other entities in farming assemblages. For example, during our fieldwork, farmers demonstrated how leaves of the Pongammia trees shield sunlight from adjoining food crops (see Figure 3). Farmers also acted as spokespersons for their crops that struggled to grow roots amidst Pongammia trees' extensive root system. Such voices raised by farmers, and produced by agricultural assemblages, were missing from the 2009 policy.

Furthermore, biodiesel feedstock trees on farm boundaries competed with the many other uses of these boundaries. In agricultural assemblages, the boundaries played a role as grazing patches for cattle, as pathways providing access to other people's lands, and as grounds for planting fruit or timber trees. Many of these uses of farm boundaries yielded useful returns to farmers, but required less labour than harvesting biodiesel feedstock. Throughout our fieldwork, smallholder farmers and farmworkers voiced these issues based on knowledges

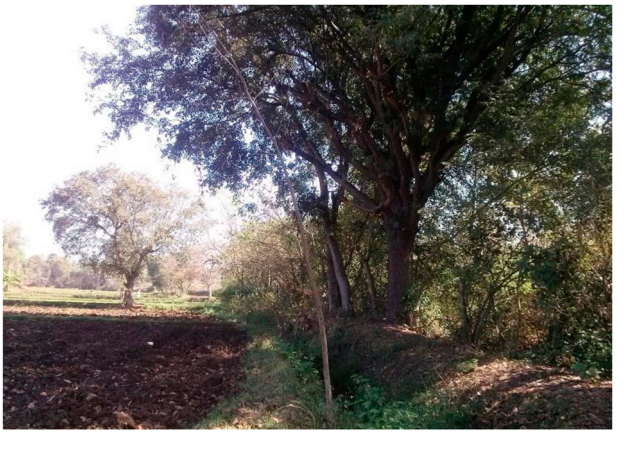

Figure 3. Pongamia trees' large canopies casting a shade on the main food crops grown by farmers. Such shade and the trees' extensive root systems reduced food crop productivity, according to farmers.

produced by their political assemblages through everyday labouring and farming practices. In addition, activists from organizations such as the SPWD acted as spokespersons for forms of competition arising out of growing biodiesel on village lands otherwise used for grazing and firewood collection. This competition risked compromising food production and wider rural sustainability, as biodiesel production was promoted to achieve policy targets (see e.g. Lavanya, 2007).

Unfortunately, such voices of 'competition' were rarely raised outside the local situations in which competition actually took place. Perhaps due to the challenges they posed to the Indian government's biodiesel promotion, such voices are not made to count as evidence in the 2009 policy. If included as evidence, diverse voices could highlight forms of competition beyond fuel vs. food security that dominated the 2009 policy proposition. For example, the inclusion of diverse voices could have higlighteded how competition can take place through roots systems of biodiesel feedstocks and the shadow cast on food crops by the feedstocks' foliage, even when they were grown on lands where no food was normally grown. The exclusion was extended also to non-edible products such as soaps and biopesticides produced from oilseeds. By excluding diverse voices, and by marginalizing associated political assemblages, the policy proposition's repetitive singularity could be claimed as easily transferable to different socio-material settings. According to the policy, non-edible oilseeds could be grown anywhere without worrying about (food vs. fuel) 'competition,' as long as food cultivation was not practised in the same location.

Jatropha Curcas and 399 Other Non-edible Oilseed Species

'There are over 400 species of trees bearing non-edible oilseeds in the country. The potential of all these species will be exploited, depending on their techno-economic viability for the production of biofuels' (Government of India, 2009, p. 7). In contrast, the 2003 Mission observed: 'There are many tree species which bear seeds rich in oil having properties of an excellent fuel and which can be processed into a diesel-substitute. […] to start the programme, the advantage is clearly in favour of Jatropha' (Planning Commission, 2003, p. 111).

Moving beyond the 2003 Mission's focus on Jatropha, the 2009 policy broadened the scope of biodiesel production to more than 400 oilseed species. Choosing the right species out of these 400 different species was made contingent on 'techno-economic viability,' a term that was not further defined in the policy. In contrast, the 2003 Mission offered concrete reasons for selecting Jatropha curcas including its supposed high yield (with low input requirements and short maturation time), its carbon-storing ability, and the medicinal value of its leaves and stems.

Widening the scope from Jatropha curcas to over 400 species was linked with many voices produced by political assemblages of biodiesel cultivation between

2003 and 2009. Earlier in this paper, we highlighted the issue of actual Jatropha yields that deviated from the 2003 Mission's prediction. Our interlocutors further noted that to produce sizeable yields, Jatropha plants needed much longer than the two years noted in the 2003 Mission. They also highlighted that while some plants produce high yields of seeds, the oil content of each seed was often very low.

We learnt from the interlocutors that many of these voices had been raised earlier during biofuel meetings organized by government bodies (attended by farmers, businesses, and researchers) and in reports produced by research insitutes (e.g. Singh *et al.*, 2006). Yet, the same voices underscoring the highly variable performance of Jatropha curcas plants were not included as 'evidence' in formal gatherings and reports. As a result, Jatropha's performance was turned into a repetitive singularity, in relation to the 2003 Mission' articulation of expected yields. Jatropha's diverse production assemblages raised the spectre of uncertainties encountered in practice, contingent on soil quality of the lands on which Jatropha was grown, the farm-inputs that could be afforded, the rainfall patterns experienced, and the care given to the plants while also fulfilling other domestic and livelihood responsibilities. Such uncertainties highlighted the difficulties of producing the biodiesel feedstock in ample quantities to fulfill the 2003 blending targets. In turn, these difficulties not only forced the government to revise its blending targets in the 2009 policy, it also resulted in broadening the scope of the policy to include a large number of oilseed species. Eventually, the policy articulated an expectation that its blending targets could be met if a wide variety of oilseed species were included. Yet, this articulation was not justified through the inclusion of diverse voices as 'evidence' that demonstrated how unlikely it was that the blending targets could actually be met.

Discussion and Conclusions

In this paper, we have studied how India's national policy marginalized the diversity of voices based on multiple knowledges related to biodiesel production. Focusing on the period between 2003 and 2009, we observed the production of diverse knowledges by *political assemblages* that cultivate, process, and observe biodiesel feedstocks in India. Rather than taking seriously these diverse voices, India's 2009 policy attempts to promote biodiesel production as a *repetitive singularity*. Doing this, the policy relies on dominant techno-scientific knowledges as 'evidence' produced by modern expert assemblages, while excluding plural contested voices of 'biodiesel promotion.' The policy thus obscures the work of many political assemblages that produce the knowledges represented by the plural voices. In this way, the policy further marginalized the 'excluded,' both humans such as smallholders and farmworkers and non-humans such as 'degraded lands' and biopesticides produced using oilseeds (that are represented by their respective spokespersons across agriculture, activism, and academia).

By marginalizing diverse voices and obscuring their political assemblages, the repetitive singularities composing a policy can hide the more or less powerfully entrenched interests of actors benefitting from the policy's promoted interventions. For example, there was little discussion in India's biofuel policy of substituting fossil fuel imports with joint venture profiteers setting up biodiesel facilities (and exacerbating rural land grabs). Similarly, the interests of the Indian automotive industry were hidden from view, who were likely to be some of the prime beneficiaries of diesel-based mobility at the expense of alternatives such as bicycling. Earlier critical research on biofuels highlighted these wider political-economic interests underpinning pro-biofuel policies (e.g. Franco *et al.*, 2010; White and Dasgupta, 2010; Levidow *et al.*, 2012; Chaliganti and Müller, 2016; Oliveira *et al.*, 2017). They did not, however, investigate the politics of excluding diverse knowledges and of obscuring multiple assemblages, in shaping and legitimizing biofuel policies in India.

Complementing the political-economic analyses, we have shown how modern expert voices were made dominant as 'evidence' (often manifesting as repetitive singularities) in India's 2009 biofuel policy, while their political assemblages were hidden from view. The latter process was the ontological counterpart of obscuring elite political-economic interests in biofuel policies. Both types of obscuring relied on elite voices that represented expert knowledges associated with modern sciences, engineering, and the social sciences (particularly economics). Extracted from the political assemblages of their uncertain construction, the 'apolitical' and 'universal' language of expert knowledges provided the discursive curtain of evidence-based certainty that was articulated in policy. Operating behind this policy curtain, powerful economic interests promoted the entities and assemblages that benefit them, while excluding weaker voices and obscuring their political assemblages.

While documenting many such situated exclusions, our analysis highlights that policy propositions must not be considered as easily transferrable to diverse socio-material situations. Situated contingency can be included in policymaking processes, if they are made sensitive to ontological differences between political assemblages across socio-material settings. Such sensitivity to differences between assemblages, and thereby between the voices they produce, highlights the importance of approaching policies as interventions that make realities. Not only do the policies help make new socio-material realities as they are enacted, they are also made by the socio-material realities formed of (expert) assemblages through which policy knowledges are produced. This points to a normative question: what kind of 'sustainable' realities need to be promoted by policies such as those for biofuel development, in order to address climate change and other forms of unsustainability produced by modernization in India (Arora *et al.*, 2019)?

The first normative implication stemming out of our analysis is that policymaking must resist turning into repetitive singularities the entities, practices

or realities that are promoted. Rather than using repetitive singularities to promote the new entities (or realities) as 'sustainable,' policymaking must *politicize sustainable development* by taking seriously the diverse voices attached to each new entity. Taking an entity's diverse voices seriously points to the recognition of how socio-material relations (of power) constitute the political assemblages of knowledge production associated with the entity. Taking diverse voices seriously also implies resistance against the assimilation or disqualification of weaker voices by more powerful ones (Arora, 2019). Taking diverse voices seriously thus means 'putting the last first' (Chambers, 1983), by making central in policy the voices raised by the most marginalized actors in society such as landless workers and smallholders.

Politicization of policymaking for sustainable development relates to knowledges in two ways: epistemological and ontological. The former points to political contestation and deliberation between diverse competing and collaborating voices based on alternate knowledges. This requires asking questions such as: how and why are particular 'expert' knowledges prioritized as 'evidence' in policy? How can plural knowledges be taken seriously through participatory policymaking? Asking such questions in our analysis, we have tried to show that they are usefully addressed by directing attention to the political assemblages in which knowledges are relationally produced. We have documented how voices raised by a range of actors in society, such as farmers and activists, are not just unscientific and non-technical opinions. But rather, they are based on diverse knowledges produced through socio-material relations in political assemblages that enact practices such as farming and activism.

Ontological politics begins by making public the political assemblages of knowledge production (Latour and Wiebel, 2005). However, such making public of assemblages offers no guarantees for inclusive policy, due to two kinds of adverse possibilities. First, it can allow policy experts to mobilize the prevailing dominance of modern 'techno-scientific' facts as apolitical evidence produced by ostensibly well-managed laboratories and test stations. These can then be argued to be generally applicable, further extending the dominance of modern facts in formatting realities. Second, by belittling the marginality and informality of assemblages that produce diverse voices raised by civil society practitioners such as smallholders and activists, alternate trajectories of socio-material development beyond modernization are marginalized (Arora *et al.*, 2019). These ontological politics highlight questions such as: how can the world-making power of modernizing policies be limited? How can the scope of resistance against modern power/knowledge be expanded? How can alternate trajectories based on marginalized people's knowledges be promoted?

Rather than offering definitive 'solutions' to these questions of ontological politics, we conclude with three proposals for more inclusive policymaking: (a) articulation of diverse voices associated with people and things, but

particularly the marginalized voices in each socio-material setting; (b) recognizing each entity's multiplicity produced by different relational compositions of political assemblages; and (c) highlighting the adjustments entailed in translating a policy from one socio-material setting to another. We hope that these proposals will be experimented with and rearticulated, particularly in actual practices performed by policymaking and knowledge production assemblages.

Note

1. A standardized reference for colour coding samples of soil (Latour, 1999, pp. 58–61).

Acknowledgements

We would first of all like to thank those who raised their voices in the context of this study, especially those whose voices were marginalized in the 2009 biofuel policy. The first author acknowledges research funding from the Netherlands Science Organization (NWO), grant number 313-99-210. The authors are grateful to the anonymous referees and the journal editors for their valuable comments.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO): [Grant Number 313-99-210].

Notes on contributors

Evelien de Hoop is a postdoctoral transdisciplinary researcher at the Athena Institute, Vrije Universiteit Amsterdam, in the Netherlands. Her research focuses on the knowledge politics of sustainability. Based on ethnographic fieldwork among farmers and other biofuel stakeholders in India and among stakeholders of European smart city experiments, she has contributed the insights from her STS-informed research to a variety of empirically relevant domains as well as STS debates. She is currently exploring the role of knowledge production in (un)sustainable healthcare systems.

Saurabh Arora is a senior lecturer at Science Policy Research Unit, University of Sussex, UK. His research focuses on the politics of sustainability in agriculture and energy. Mapping everyday practices in parts of India and East Africa, he has contributed to debates on participation (agency, democracy, multiplicity) and power (control, exclusion, marginalization), in the production of knowledges and policies. Fields of study include rural poverty in India and Kenya, biofuels, 'green revolutions,' genetic engineering, agroecology, 'smart' urbanism, post-disaster reconstruction, and climate resilience. Ongoing research explores politics of care and conviviality in possibilities for decolonizing modernity.

ORCID

Evelien de Hoop http://orcid.org/0000-0001-5837-3756

References

Agoramoorthy, G. and Patel, P. (2011) India's biofuel development: Swings and roundabouts, *Environmental Science & Technology*, 46, pp. 589–590.

Agrawal, A. (1995) Dismantling the divide between indigenous and western knowledge, *Development and Change*, 26(3), pp. 413–439.

Altenburg, T., Dietz, H., Hahl, M., Nikolidakis, N., Rosendahl, C. and Seelige, K. (2009) *Biodiesel in India: Value Chain Organisation and Policy Options for Rural Development*, Report (Bonn, Germany: German Development Institute).

Ariza-Montobbio, P., Lélé, S., Kallis, G. and Martinez-Alier, J. (2010) The political ecology of Jatropha plantations for biodiesel in Tamil Nadu, India, *Journal of Peasant Studies*, 37/4, pp. 875–897.

Arora, S. (2012) Farmers' participation in knowledge circulation and the promotion of agroecological methods in South India, *Journal of Sustainable Agriculture*, 36/2, pp. 207–235.

Arora, S. (2019) Admitting uncertainty, transforming engagement: Towards caring practices for sustainability beyond climate change, *Regional Environmental Change*, 19/6, pp. 1571–1584.

Arora, S., Baan Hofman, N., Koshti, V. and Ciarli, T. (2013) Cultivating compliance: Governance of North Indian organic basmati smallholders in a global value chain, *Environment and Planning A*, 45, pp. 1912–1928.

Arora, S., Vijayabaskar, M., Sharma, D. and Stirling, A. (2019) Sustainable development through diversifying pathways in India, *Economic and Political Weekly*, 54(46), pp. 32–37.

Baka, J. (2013) The political construction of wasteland: governmentality, land acquisition and social inequality in South India, *Development and Change*, 44/2, pp. 409–428.

Baka, J. (2014) What wastelands? A critique of biofuel policy discourse in South India, *Geoforum*, 54, pp. 315–323.

Barry, A., Born, G. and Weszkainys, G. (2008) Logics of interdisciplinarity, *Economy and Society*, 37/1, pp. 20–49.

Biswas, P. K., Pohit, S. and Kumar, R. (2010) Biodiesel from jatropha: Can India meet the 20% blending target?, *Energy Policy*, 38, pp. 1477–1484.

Boccagni, P. (2014) From the multi-sited to the in-between: ethnography as a way of delving into migrants' transnational relationships, *International Journal of Social Research Methodology*, 19(1), pp. 1–16.

Brugnach, M., Craps, M. and Dewulf, A. (2017) Including indigenous peoples in climate change mitigation: addressing issues of scale, knowledge and power, *Climatic Change*, 140/1, pp. 19–32.

Callon, M. (1986) Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St. Brieuc Bay, in: J. Law (Ed.), *Power, Action and Belief: A New Sociology of Knowledge?* pp. 196–233 (London: Routledge Kegan Paul).

Callon, M. (2008) Economic markets and the rise of interactive agencements: from prosthetic agencies to habilitated agencies, in: T. Pinch and R Swedberg (Eds) *Living in a Material World*, pp. 29–56 (London: MIT Press).

Callon, M., Lascoumes, P. and Barthe, Y. (2009) *Acting in an Uncertain World: An Essay on Technical Democracy* (London: MIT Press).

Carolan, M. (2010) *Decentering Biotechnology: Assemblages Built and Assemblages Masked* (Farnham: Ashgate).

Chaliganti, R. and Müller, U. (2016) Policy discourses and environmental rationalities underpinning India's biofuel programme, *Environmental Policy and Governance*, 26, pp. 16–28.

Chambers, R. (1983) *Rural Development: Putting the Last First* (Harlow: Prentice Hall).

De Hoop, E. (2018) Understanding marginal changes in ecosystem services from biodiesel feedstock production: A study of Hassan Bio-fuel park, India, *Biomass and Bioenergy*, 114, pp. 55–62.

Dalemans, F., Muys, B. and Maertens, M. (2019) Adoption constraints for small-scale agroforestry-based biofuel systems in India. *Ecological Economics*, 157, pp. 27–39.

De Hoop, E. and Arora, S. (2017) Material meanings: 'waste' as a performative category of land in colonial India, *Journal of Historical Geography*, 55, pp. 82–92.

De Hoop, E., Pols, A. J. K. and Romijn, H. A. (2016) Limits to responsible innovation, *Journal of Responsible Innovation*, 3/2, pp. 110–134.

Dewangan, A., Yadav, A. K. and Mallick, A. (2018) Current scenario of biodiesel development in India: prospects and challenges, *Energy Sources, Part A: Recovery, Utilization, and Environmental Effects*, 40, pp. 2494–2501.

Franco, J., Levidow, L., Fig, D., Goldfarb, L., Hönicke, M. and Luisa Mendonça, M. (2010) Assumptions in the European Union biofuels policy: frictions with experiences in Germany, Brazil and Mozambique, *The Journal of Peasant Studies*, 37(4), pp. 661–698.

Freeman, R. (2012) Reverb: policy making in wave form, *Environment and Planning A*, 44, pp. 13–20.

German, L., Goetz, A., Searchinger, T., de L.T. Oliveira, G., Tomei, J., Hunsberger, C., and Weigelt, J. (2017) Sine Qua Nons of sustainable biofuels: Distilling implications of under-performance for national biofuel programs, *Energy Policy*, 108, pp. 806–817.

Gonzalez, C. G., (2018) An environmental justice critique of biofuels, in: R Salter et al. (Ed.) *Energy Justice: US and International Perspectives* (Edward Elgar Publishing). Available at SSRN: ssrn.com/abstract=3274097.

Gidwani, V. K. (1992) 'Waste' and the permanent settlement in Bengal, *Economic and Political Weekly*, 27(4), PE39-PE46.

Gopinathan, M. C. and Sudhakaran, R. (2009) Biofuels: opportunities and challenges in India, *In Vitro Cellular and Developmental Biology – Plant*, 45, pp. 350–371.

Government of India. 2009. National policy on biofuels.

Haraway, D. (1991) *Simians, Cyborgs and Women: The Reinvention of Nature* (New York: Routledge).

Holmes, J. and Clark, R. (2008) Enhancing the use of science in environmental policy-making and regulation, *Environmental Science & Policy*, 11, pp. 702–711.

Jasanoff, S. (ed.) (2004) *States of Knowledge: The Co-production of Science and Social Order* (London: Routledge).

Jasanoff, S. and Kim, S.-H. (2009) Containing the atom: Sociotechnical imaginaries and nuclear regulation in the U.S. and South Korea, *Minerva*, 47(2), pp. 119–146.

Jungman, A. A., Bhat, M. G., Jayachandran, K. and Gowda, B. (2016) An assessment of biodiesel feedstock conversion efficiency: a case study of decentralised biofuel production program in rural India, *International Journal of Renewable Energy Technology*, 8(1), pp. 47–63.

Kanninen, M., Murdiyarso, D., Seymour, F., Angelsen, A., Wunder, S. and German, L. (2007) *Do Trees Grow on Money? The Implications of Deforestation Research for Policies to Promote RRED* (Bogor: Centre for International Forestry Research (CIFOR)).

Klaus, D., Derek, B., Jonathan, L., Andrew, N., Harris, S., and Mercedes, S. (2011) *Rising Global Interest in Farmland: Can it Yield Sustainable and Equitable Benefits?* Agriculture and Rural Development (Washington, DC: World Bank).

Kant, P. and Wu, S. (2011) The extraordinary collapse of Jatropha as a global biofuel, *Environmental Science & Technology*, 45/17, pp. 7114–7115.

Kothari, B. (2002) Theoretical streams in marginalized peoples' knowledge(s): systems, asystems, and subaltern knowledge(s), *Agriculture and Human Values*, 19(3), pp. 225–237.

Kumar, S., Chaube, A. and Jain, S. K. (2012) Critical review of jatropha biodiesel promotion policies in India, *Energy Policy*, 41, pp. 775–781.

Lahiri, S. 2009. *Losing the plot: The threats to community land and the rural poor through the spread of biofuel jatropha in India*. Report (Brussels, Belgium: Friends of the Earth Europe).

Latour, B. (1988) *The Pasteurization of France* (London: Harvard University Press).

Latour, B. (1999) *Pandora's Hope: Essays on the Reality of Science Studies* (London: Harvard University Press).

Latour, B. (2003) What if we talked politics a little, *Contemporary Political Theory*, 2, pp. 143–164.

Latour, B. (2004) *Politics of Nature: How to Bring the Sciences into Democracy* (Cambridge, MA: Harvard University Press.

Latour, B. (2005) *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford: Oxford University Press.

Latour, B. (2010) An attempt at a "Compositionist manifesto", *New Literary History*, 41, pp. 471–490.

Latour, B. and Wiebel, P. (eds.) 2005 *Making Things Public: Atmospheres of Democracy* (Cambridge, MA: The MIT Press).

Lavanya, S. N. 2007. *National consultation on "Bio"fuels in India: will they deliver or destroy?* Report (Hyderabad, India: Deccan Development Society).

Lave R. (2015) Introduction to special issue on critical physical geography. Progress in Physical Geography, *Earth and Environment*, 39(5), pp. 571–575.

Levidow, L., Papaioannou, T. and Birch, K. (2012) Neoliberalism, technoscience and the environment, in: L. Pellizoni and M Ylönen (Eds) *Neoliberalism and Technoscience: Critical Assessments*, pp. 159–186 (London: Routledge).

Li, T. M. (2007) *The Will to Improve: Governmentality, Development, and the Practice of Politics* (London: Duke University Press).

Lövbrand, E. (2011) Co-producing European climate science and policy: a cautionary note on the making of useful knowledge, *Science and Public Policy*, 38/3, pp. 225–236.

Mabeza, C. (2013) Metaphors for climate adaptation from Zimbabwe: Zephaniah Phiri Maseko and the marriage of water and soil, in: L Green (Ed) *Contested Ecologies: Dialogues in the South on Nature and Knowledge*, pp. 126–139 (Cape Town: HSRC Press).

Misra, R. D. and Murthy, M. S. (2011) Jatropa-the future fuel of India, *Renewable and Sustainable Energy Reviews*, 15, pp. 1350–1359.

Mitchell, T. (2002) *Rule of Experts: Egypt, Techno-politics, Modernity* (Berkeley: University of California press.

Mol, A. (2002) *The Body Multiple: Ontology in Medical Practice* (Durham: Duke University Press).

Neville, K. J. (2015) The contentious political economy of biofuels, *Global Environmental Politics*, 15(1), pp. 21–40.

Ng'ombe, A., Keivani, R. and Stubbs, M. (2012) Participatory approaches to land policy reform in Zambia: potential and challenges, *Environment and Planning A*, 44, pp. 1785–1800.

Nowlin, M. C. (2011) Theories of the policy process: state of the research and emerging trends, *The Policy Studies Journal*, 39(S1), pp. 41–60.

Oliveira, G., McKay, B. and Plank, C. (2017) How biofuel policies backfire: misguided goals, inefficient mechanisms, and political-ecological blind spots, *Energy Policy*, 108, pp. 765–775.

Palmer, J. R. (2014) Biofuels and the politics of land-use change: tracing the interactions of discourse and place in European policy making, *Environment and Planning A*, 46, pp. 337–352.

Parkhurst, J. (2017) *The Politics of Evidence: From Evidence-based Policy to the Good Governance of Evidence* (Oxford: Routledge).

Planning Commission. (2003) *Report of the Committee on Development of Bio-Fuel* (Delhi, India: Government of India.

Pradhan, S. and Ruysenaar, S. (2014) Burning desires: untangling and interpreting 'pro-poor' biofuel policy processes in India and South Africa, *Environment and Planning A*, 46(2), pp. 299–317.

Prince, R. (2010) Policy transfer as policy assemblage: making policy for the creative industries in New Zealand, *Environment and Planning A*, 42, pp. 169–186.

Rajagopal, D. (2008) Implications of India's biofuel policies for food, water and the poor, *Water Policy*, 10/S1, pp. 95–106.

Reinhardt, G., Gärtner, S., Nettenmaier, N., Munch, J. and Falkenstein, E. 2007. *Screening Life Cycle Assessment of Jatropha Biodiesel*. Report (Stuttgart, Germany: Dailmer AG).

Rietig, K. (2016) The links among contested knowledge, beliefs, and learning in European climate governance: from consensus to conflict in reforming biofuels policy, *Policy Studies Journal*, 46(1), pp. 137–159.

Rittenburg, R. A., Kummel, M. and Perramond, E. P. (2011) The local climate-development nexus: Jatropha and smallholder adaptation in Tamil Nadu, India, *Climate and Development*, 3/4, pp. 328–343.

Rometsch, J. J. (2012) India's agrofuel policies from a feminist-environmentalist perspective, in: T. Potthast, and S. Meisch (Eds) *Climate Change and Sustainable Development: Ethical Perspectives on Land Use and Food Production*, pp. 233–238 (Wageningen: Wageningen Academic Publishers).

Romijn, H. A. (2011) Land clearing and greenhouse gas emissions from Jatropha biofuels on African Miombo woodlands, *Energy Policy*, 39, pp. 5751–5762.

Scott, J. C. (1998) *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press.

Shahare, M. and Thayyil, N. (2020) Responsibility, representation and participation: Burueacratic steering of biofuel research, *Science, Technology & Society*, doi:10.1177/0971721820903003

Shiva, V. and Shankar, M. (2008) *Biofuel Hoax: Jatropha and Land Grab* (New Delhi: Navdanya).

Singh, B., Swaminathan, R. and Ponraj, V. 2006. *Biodiesel Conference Towards Energy Independence – Focus on Jatropha. Report with papers presented at the Conference Rashtrapati Nilayam*, Bolaram, Hyderabad, India.

Stirling, A. (2008) "Opening up" and "closing down" power, participation, and pluralism in the social appraisal of technology, *Science, Technology and Human Values*, 33/2, pp. 262–294.

Stirling, A. 2015. Towards Innovation Democracy? Participation, responsibility and precaution in innovation governance. *STEPS Working Paper* 78, Brighton, UK.

Strassheim, H. and Kettunen, P. (2014) When does evidence-based policy turn into policy-based evidence? Configurations, contexts and mechanisms, *Evidence & Policy: A Journal of Research, Debate and Practice*, 10(2), pp. 259–277.

Ureta, S. (2014) Policy assemblages: proposing an alternative conceptual framework to study public action, *Policy Studies*, 35/3, pp. 303–318.

Verran, H. (2009) On assemblage, *Journal of Cultural Economy*, 2/1-2, pp. 169–182.

Wesselink, A. and Paavola, J. (2011) Rationales for public participation in environmental policy and governance: practitioners' perspectives, *Environment and Planning A*, 4, pp. 2688–2704.

Wetzstein, S. and Le Heron, R. (2010) Regional economic policy 'In-the-making': Imaginaries, political projects and institutions for Auckland's economic transformation, *Environment and Planning A*, 42(8), pp. 1902–1924.

White, B. and Dasgupta, A. (2010) Agrofuels capitalism: a view from political economy, *The Journal of Peasant Studies*, 37(4), pp. 593–607.

Wynne, B. (1992) Uncertainty and environmental learning: reconceiving science and policy in the preventive paradigm, *Global Environmental Change*, 2(2), pp. 111–127.